



Grant Agreement number: **73248**

Acronyme: **TINOHEAT** Activity: **SMEInst-1-09-2016**

Title:

Reduced energy consumption and carbon footprint of the plastic packaging industry, using a novel environmentally friendly nanoparticle based industrial process



PET flasks with 0, 10 and 250 ppm (from left to right) of new plasmonic nano-ceramic re-heater

## **Summary for publication**

### **Summary of the context and overall objectives**

General aim of the project is to reduce energy consumption and carbon fingerprint in plastic industry. Thermoplastic polymers such as Polyethylene terephthalate (PET), Polyethylene (PE), Polypropylene (PP) being initially manufactured as granulate underwent afterwards different re-shaping under re-heating to

final articles. Enormous energy is consumed at such re-heating, very often energy costs contribute 50% and more to the total self-cost of final article.

These energy losses are especially big at such mass manufacturing as plastic bottles industry. First so-called “preforms” are manufactured from PET granulate and then preforms are blown to the different final plastic bottles under the heating, normally by Infrared (IR) lamps. Energy consumed at this stage determines the self-cost of final bottle. Most of energy lost because of transparency of polymer for IR irradiation. To reduce energy losses different “re-heaters” are applied, such as graphite and mineral pigments which have higher IR adsorption than polymer. However, these re-heaters are effective only at high concentration and change optical and mechanical properties of polymer. Polymer is no more transparent which very important feature for plastic bottles. Customers mostly want to see what is inside. Requested high content of such re-heaters make bottle also expensive.

A Project was suggested to develop new cheap plasmonic nanoceramic particles which are effective as IR re-heaters even at extremely low concentration in ppm (particles per million) range and thus does not change appearance of polymer and do not remarkably contribute to self-costs. To approach this goal, it was necessary to develop new approach based on Inductively Coupled Plasma (ICP) technology. Such technology should be ecologically friendly (free of toxic and corrosive precursors and exhausts) and give clean product free of toxic admixtures, while final application concerns to food containers/bottles.

#### **Work performed from the beginning of the project to the end of the period covered by report.**

A feasibility study was conducted and a business plan developed. The current ICP plant was improved. The different process routes were tried and resulted nano-ceramics investigated. The best embodiments chosen by spectroscopy criteria were tested also for preform blowing step. Technical evaluation shows that:

- It is possible to manufacture superior clean product by developed technology
- Mass manufacturing of this product (plasmonic nano-ceramic re-heater) is possible
- Material and energy costs to produce 1 kg product by current technology were estimated and extrapolated to next more powerful ICP plant.
- Technology and nano-materials suppliers market was evaluated for possible competitors and it was found that there is no analogous technology and product on European market. Moreover, even worldwide such technology is not commercially available. Existing solutions possess inherent drawbacks.
- Both technology and product are new and patentable.
- Performed trials on preform re-heating show the energy saving is at least 30% at just 10 ppm of new re-heater in PET (it corresponds to 10 g of plasmonic re-heater per 1 Ton of PET). Sufficient benefit for customers was preliminary estimated.
- Potential market for new product was analyzed. It was established, that potential market for this re-heater is very big just for plastic bottle industry while there are many other sectors where this re-heater can be applied. Acceptable market sale prices were estimated.
- On the basis of data accumulated the conservative business plan was drafted. It shows opportunity to approach good revenue already at 4<sup>th</sup> year from the start of financing.

### **Progress beyond the state of the art and expected impact**

Developed technology as the sum of new hardware and process parameters has unique patentable features, Such technology does not exist at industrial level neither in Europe or Worldwide. Realization of technology at industrial level will push technology level of Europe and remarkably improve global competition situation.

In contrast to known closest technical solutions the developed technology is clean “green” technology, it does not involve any toxic precursors and generates no toxic corrosive exhausts. Technology is applicable not only for given plasmonic nano-ceramic re-heater but for manufacturing of any other refractory nano-ceramics. Establishing of industrial ICP plants will improve ecology situation In Europe.

It need to be stressed, that the Energy savings by using the TiNO Product during PET processing are substantial. If used on a global scale and for all anticipated and not yet anticipated uses the global energy savings could accumulate to several TWh (Terra Wats) or MT (Mega Tons) CO<sub>2</sub>. Furthermore, it must be emphasized that development was made in the EU alone.

In given project will be further realized the new highly qualified working places in Europe will be generated and not only at PlasmaChem GmbH but also in plastic bottle industry because application of this re-heater will require manufacturing of special “masterbatches” with high concentration of plasmonic nano-ceramic in PET and this new job will be performed by other specialized European companies – suppliers of masterbatches.

Indirectly new job places will be generated also in European big plastic industry because new technology makes plastic goods cheaper and it means more competitive and sellable at the world market. That, in turn means expansion of production and more working places in Europe.